

The Vela pulsar, the key?

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Abstract. Of all pulsars known Vela has been one of the most productive in terms in understanding pulsars and their characteristics. We present the latest results derived from Australian telescopes. These include a more accurate pulsar distance, a more precise pulsar local space velocity, a new model of the spin up and the association of a radio nebula with the X-ray pulsar wind nebula.

Introduction

We have observed the pulsar Vela with a range of Australian telescopes. Using the Long Baseline Array (LBA) we have measured the parallax of pulsar, and thus the distance. Using the Australia Telescope Compact Array (ATCA) we have found the radio pulsar wind nebula (PWN) that surrounds the X-ray PWN. Using the University of Tasmania's dedicated pulsar monitoring telescope in Hobart we have detected the core interaction in the spin up of the pulsar in the glitch of 2000.

Observations

The pulsar monitoring telescope at Hobart is a fourteen meter radio telescope dedicated to timing the Vela pulsar. It collects three frequencies (635, 990, 1340-MHz), and the central one is collected unfolded for high resolution timing analysis (Dodson et al.(2002)). The 'fast component' observed, which was fitted with a decay time 1.2 minutes, has been reanalysed with a more realistic model. We marginally detect the core interaction in the spin up (Lewis(2003)).

The ATCA has been used to map the radio PWN at 21cm, 13cm, 6cm and 3cm. Because we used compact configurations with better sensitivity to low surface brightness objects we are able to map the whole nebula, unlike previous observations (Bietenholz et al.(1991)).

We have used a single baseline from the LBA to measure the on sky motion of the Vela pulsar compared with the extra galactic source Vela-G. We have measured the proper motion and parallax of the Vela pulsar to an unprecedented accuracy ($\mu_{\alpha\cos\delta} = -49.68 \pm 0.06$, $\mu_{\delta} = 29.9 \pm 0.1$ mas yr⁻¹, $\pi = 3.5 \pm 0.2$ mas), and have been able to convert these back to the space velocity and position

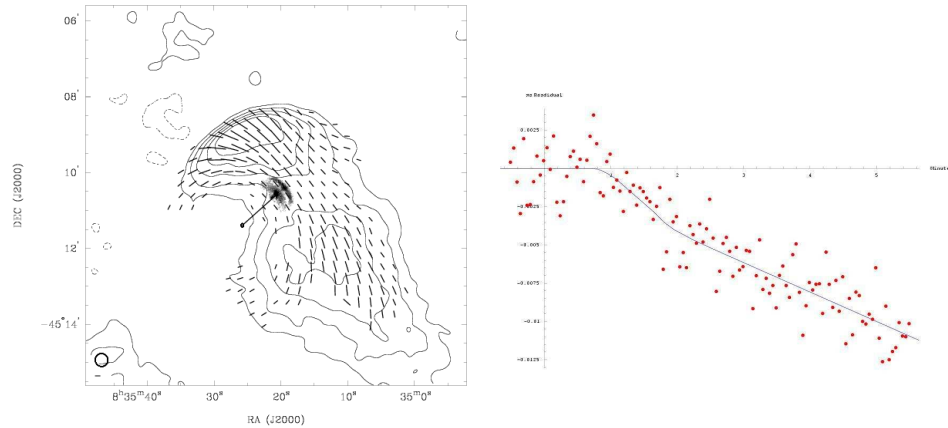


Figure 1. a) The Chandra observation of the Vela PWN (grey scale) and the 5 GHz Radio contours (-1,1,2,3,4,5 mJy/beam). The derotated magnetic field lines are overlaid. The proper motion vector shows the distance travelled in 1000 years, and ends with the three sigma error ellipse. b) 3 second integrations of the single pulse data across the 2000 glitch. The fit is for the new model of crust-core interaction, and illustrates the limits on this from the data.

angle of the pulsar in its local environment with greater precision than previously possible ($61 \pm 2 \text{ km s}^{-1}$ at $301^\circ \pm 1.8$), because of the unambiguity in the radio reference frame. We have found an arithmetic error in Caraveo et al.(2001) and, once corrected, their results agree with ours (Caraveo, personal comms).

Future observations

We have funding for a coherently dedispersed 30MHz backend for the 635MHz IF on the pulsar timing telescope. This should allow us an increase in sensitivity of an order of magnitude over the previous observations.

We plan to observe at the ATCA the radio nebula at higher frequencies to find the turn over frequency, and model the emission from the X-rays down to the radio frequencies. We are observing at the VLA to get sensitive rapid observations to measure changes associated with the recently discovered X-ray outer jet (Pavlov et al.(2001)).

The limitation in the accuracy of the VLBI observation is the solar motion parameters, and we can not improve on this. Nevertheless we are planning to use Vela as a demonstration source in a baseband e-VLBI experiment.

References

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